temperature; whence the following law. The pressure of steam generated in the usual steam-boiler is directly proportional to the fourth power of its temperature, when measured by a true scale.

It being assumed that 100 degrees is the temperature of steam when its pressure is in equilibrium with a column of 30 inches of mercury, or with the pressure of one atmosphere, then F being the pressure in atmospheres, at any temperature t,

$$F=\left(\frac{t}{100}\right)^4.$$

A comparison is instituted between theoretic experiments of the Academy of Sciences and the results of this formula, from which it appears that the temperatures deduced from the formula are invariably in defect, the greatest difference being 3·51, and the least 2·02.

2. "On the means adopted in the British Colonial Magnetic Observatories for determining the absolute values, secular change, and annual variation of the Magnetic Force." By Lieut.-Col. Edward Sabine, R.A., For. Sec. R.S.

The determination of the mean numerical values of the elements of terrestrial magnetism in direction and force at different points of the earth's surface (the force being expressed in absolute measure, intelligible consequently to future generations, however distant, and conveying to them a knowledge of the present magnetic state of the globe), and the determination of the nature and amount of the secular changes which the elements are at present undergoing, are, as the author states, the first steps in that great inductive inquiry by which it may be hoped that the inhabitants of the globe may at some date, perhaps not very distant, obtain a complete knowledge of the laws of the phenomena of terrestrial magnetism, and possibly gain an insight into the physical causes of one of the most remarkable forces by which our planet is affected.

After stating the inadequacy of the instruments originally proposed by the Royal Society, to the attainment of all the objects for which they had been designed, the author refers to the modifications which had been introduced, in the instruments and methods of observation for the determination of the absolute values, and the secular changes of the horizontal component of the magnetic force. He then gives the series of the results of the monthly observations at Toronto from January 1845 to April 1849 as relatively correct; and from this series, regarding each monthly determination as entitled to equal weight, and taking the arithmetical mean of all the values as the most probable mean value, obtains 3·53043 as the mean value of the horizontal force at Toronto, with a probable error of $\pm$·00055; and the probable error of $\pm$·0040 for each monthly determination.

This is on the most simple hypothesis, in which neither secular change nor annual variation is supposed to exist. The monthly results however distinctly indicate a secular change, and by means of them, on the hypothesis of a uniform secular change, the author

deduces ·0042 as the annual decrease of the horizontal force during the period comprehended by the observations, the value of the force on the 1st of March 1847, the mean epoch being 3·53043, with a probable error of $\pm$·00025.

For the purpose of deducing the values of the total magnetic force and its secular change from those of the horizontal force, it is necessary to know the magnetic inclination corresponding to the epoch and its secular change. From the observations of the inclination, 75° 16′·09 is deduced as the value of this element on the 1st of March 1847, with a secular increase of 0′·89 annually; and 13·8832 as the value of the total force in absolute measure, at the same epoch. As the annual increase of 0′·89 in the inclination will not account for an annual decrease of more than ·0033 in the horizontal force, there remains ·0009 as indicative of a small annual decrease in the total force during the period of the observations, and the author considers that the probabilities are in favour of such a decrease.

The general fact of an annual variation of the horizontal force at Toronto, the force being greater in the summer than in the winter months, is shown by three independent methods of experiment, viz. the observations from which the foregoing conclusions have been drawn, the regular observations with the bifilar magnetometer, and observations undertaken expressly with the view of ascertaining the fact. The author also infers the probable existence of an annual variation of the total force, the force being greatest in the winter months, or when the sun is in the southern signs, and least in the summer months, or when the sun is in the northern signs.

The results obtained from the observations at Hobarton are next briefly stated. The investigation, conducted in the same manner as at Toronto, shows at Hobarton a decrease of *south* inclination of 0′·89 on the average of the months from April to August inclusive, that is, in the southern winter; and an increase of 0′·85 from October to February inclusive, that is, in the southern summer.

The series of observations on the horizontal force shows an annual variation of the same character as respects the seasons, and almost identical in amount with that at Toronto. In the months from October to February inclusive, or in the summer months at Hobarton, the horizontal force is ·0017 greater on the average than its mean amount; and from April to August inclusive, or in the winter months at Hobarton, it is on the average ·0013 less than its mean amount.

The inferences drawn from these variations of the inclination and horizontal force, taken jointly as respects the total force at Hobarton, are that this force is subject to an annual variation, being higher than its mean amount from October to February, and lower than its mean amount from April to August.

It thus appears that in the months from October to February the magnetic needle more nearly approaches the vertical position, both at Toronto in the northern hemisphere, and at Hobarton in the southern; and that the total force is greatest at both stations from October to February, and least from April to August.

It is much to be desired, the author states, that so remarkable a result should receive a full confirmation, by the continuance of the observations at Toronto and Hobarton for such an additional period as may appear necessary for that purpose; and that the general conclusion, indicated by the observations at those stations, should be verified by similar investigations in other parts of the globe, especially at the observatories which now exist. He conceives that these facts indicate the existence of a general affection of the whole globe having an annual period, and would appear to conduct us naturally to the position of the earth in its orbit as the first step towards an explanation of the periodic change. He further urges the importance of following up without delay, and in the most effective manner, a branch of the research which gives so fair a promise of establishing, upon the basis of competent experiment, a conclusion of so much theoretical moment.

In conclusion the author adverts briefly to considerations which may give a particular importance to accurate numerical values of the magnetic elements and their secular changes at Toronto, namely the proximity of that station to one of the two points on the northern hemisphere, which are the centres of the isodynamic loops, and are the points of the greatest intensity of the force (on the surface of the globe) of apparently two magnetic systems, distinguished from each other by the very remarkable difference in the rate of secular change to which the phenomena in each system appear to be subject.